to, could derive oxygen, is from the decomposition of water; but germinating seeds, says M. de Saussure, emit neither hydrogen nor oxygen, but only convert the oxygen gas of the air into an equal bulk of carbonic acid gas. It seems therefore, to be quite certain that the changes produced in the germinating seed cannot arise from the combination of oxygen.

Neither, in conformity to the opinion held by some, that the mucilage of the seed becomes sugar by losing a part of its carbon, can we ascribe the change of quality in the seed to the loss of that substance ; for the portion of the carbon given off by the germinating seed is exceedingly small, and we have no evidence that it is afforded by its mucilaginous matter. The chemical change, by which mucilage is con­verted into sugar, takes place also in circumstances where there is no reason to ascribe it to the loss of carbon.

That the combined action of heat and moisture will pro­duce on the *fecula* of seeds changes analogous to those which occur in germination, has been long known. Dr. Irvine long since remarked, that the farinaceous matter of seeds could thus be rendered sweet. Hence, distillers, says he, often mix not only grain imperfectly malted, but raw meal, with their malt ; and the whole being then mixed with water, and submitted to distillation, becomes sweet, and forms wines and spirits. M. Fourcroy and M. Vauquelin obtained sugar and alcohol from bruised unmalted barley, by the combined use of water and heat ; and Dr. Thomson has remarked, that the wort made from raw grain is nearly as sweet as from that which has been malted. In the ex­periments of M. Kirchoff and others, starch was converted into sugar by thirty-six hours boiling in four times its weight of water ; and, from some later trials. It would seem that saw-dust and other vegetable matters, as linen rags, may, by a similar process, be made to experience a like conver­sion. From these experiments we learn, that the conver­sion of *the fecula* of seeds into sugar is an operation purely chemical, effected by the combined and continued action of heat and water ; and since, in germination, the albumen of the seed is made to undergo a similar chemical change, under the varied operation of the same agents, may we not presume that it is accomplished in a manner somewhat similar ?

When, by germination, the albumen of the seed has been thus changed from a solid and tasteless, to a fluid and sweet­ish substance. It is brought into a condition tit for the nu­trition of the embryo. For this purpose. It is taken up, or absorbed from the cells in which it had been deposited, and conveyed to the neck of the embryo, where a part of it is carried downward to feed the radicle, and another part upward to nourish the plume.

Connected with the structure that determines the course which the nutrient matter takes on reaching the neck of the embryo, appears to be that tendency in the plumule and radicle to pursue opposite directions, in whatever posi­tion or circumstances the seed be placed to grow. These tendencies have been ascribed to the action of light on the plume, and of earth on the radicle : but the radicle equally descends, although no earth be present, and the plumule rises, although light be excluded. Others have attributed the descent of the radicle to the greeter weight of its sap, and the ascent of the plumule to the lighter condition of that fluid : but there is no evidence that, in these parts respec­tively, any such difference of sap exists. More lately. It has been supposed that gravitation acted in causing the descent of the radicle ; and attempts have been made to counteract this by force, by keeping seeds, during their evolution, in continued motion on vertical or horizontal wheels : but the results obtained seem only to prove, that, in such circum­stances, the radicle and plumule pursue, as usual, opposite directions, without affording any reason, why, in natural growth, the one always rises and the other descends. It is worthy of remark, that this tendency to descend exists only in the primary radicle or tap-root: for the lateral shoots which it puts forth extend themselves, says Du Hamel, nearly hori­zontally. In like manner, the rootlets that spring from the extremity of a cutting descend perpendicularly, while those that issue from its sides proceed horizontally. We may observe a corresponding peculiarity in the plumule and its productions. It is very singular, continues this writer, that a tree which springs from a seed raises its stem very straight : it is the same with a cutting taken from a straight stem ; but a cutting taken from a lateral branch, or the bent shoot of a tree, bends much in its growth, especially if its wood be of a hard nature.

Both the radicle and plumule, as they receive nutriment, increase in all their dimensions ; that is, both in length and breadth. The elongation of the radicle, according to Du Hamel, is produced only by the addition of new matter to its extremity, an opinion which the observations of Mr. Knight confirm. In the more succulent plumule, Du Hamel has shown, by satisfactory experiments, that elongation is produced by an extension of parts already formed, as well as by the addition of new particles ; but this extension is not observed when the new parts have acquired a certain degree of hardness. In their diametral growth. It is probable that both the radicle and plumule experience, in their tender state, some degree of expansion from the motion of their contained fluids, as well as from the addition of new matter to their exterior surface.

In this brief account of germination, we have supposed the process to be carried on in closed glass vessels, in which the progress of evolution can be observed, the agents con­cerned in carrying it on made known, and their action, to a certain extent, appreciated. In such vessels the de­velopment of the seed can be continued until all the nu­trient matter is exhausted, and the organized parts assume their peculiar forms, and execute their appropriate functions. If indeed water and air be duly supplied, the seeds of various herbs will grow and produce flowers and fruits with­out coming in contact with earth, as M. Bonnet ascertained; and in other experiments of Du Hamel, the seeds of dif­ferent trees, which had been made to germinate on wet sponges, and had their roots afterwards set in bottles so as to be in contact with water, continued to vegetate for several years, and produced annually new leaves, bark, and wood, by the aid of water alone ; so that, “ without attempting to explain how the parts of this fluid become solid. It is cer­tain,” says this excellent writer, “ that water is able to furnish the nourishment necessary to plants.” For a de­scription of the daily appearances exhibited in the evo­lution of several kinds of seeds, we must refer to our former article.

In ordinary germination, however, by the time the nu­trient matter of the seed is exhausted, the radicle has sent forth rootlets through the soil, which at once serve to fix the plant in its place, and to draw from the earth fresh materials to sustain its growth. These materials, as will afterwards be shown, undergo certain changes in the young leaves, which have now sprung forth from the plumule, and in part execute the function of cotyledons. The cotyledons, if they have risen above the surface, now fade and fall ; if they have remained beneath it, they decay and perish. In addition to water, heat, and air, the only agents required to carry on the germination of the seed, light now becomes necessary to give perfection to the plant ; and its operation in be­stowing colour and other peculiar properties on plants will be more particularly noticed hereafter. In this account of germination, we have given attention chiefly to the physical phenomena which it exhibits, reserving what we have to say of the seed, as a living body, to another occasion.